# Effects of intramammary infection and parity on calf weaning weight and milk quality in beef cows

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# Effects of intramammary infection and parity on calf weaning weight and milk quality in beef cows[1]

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**ABSTRACT:** The objectives of this study were to determine 1) the effect of intramammary infection on calf weaning weight, milk somatic cell count, and milk composition, and 2) the effect of parity on percentages of infected cows, infected quarters, and blind quarters. The number of infected quarters, milk somatic cell counts, milk components, and intramammary infection were studied at weaning in 164 beef cows. The percentage of infected cows ranged from 61.9% at first parity to 66.7% at fifth to ninth parities. Cows with three or four infected quarters had higher ($P < .01$) milk somatic cell counts than cows with zero, one, or two infected quarters. Among bacterial isolates, *Staphylococcus aureus*-infected quarters had the highest ($P < .01$) milk somatic cell count. Percentages of butterfat and lactose were lower ($P < .01$) in milk from infected quarters than from uninfected quarters. Infections by *S. aureus* and coagulase-negative staphylococci were the most common and accounted for 67 to 78% of the infections. Percentages of infected quarters and infections caused by *S. aureus* increased with parity ($P < .01$). Intramammary infections did not affect ($P > .10$) calf weaning weight. In conclusion, intramammary infection had no effect on calf weaning weight but increased milk somatic cell count and decreased the percentage of protein, lactose, solids-not-fat, and butterfat. The number of infected and blind mammary quarters increased with parity.

Key Words: Beef Cows, Infection, Mastitis, Somatic Cell Counts

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## Introduction

Most studies conducted on mastitis in cows have focused their attention mainly on dairy animals (Eberhart et al., 1987; Harmon, 1994; Nickerson et al., 1994). The types and prevalence of intramammary infections in dairy cows have been determined (Jain, 1983). Approximately 50% of dairy cows are infected in an average of two quarters, each with a pathogenic bacterium (Philpot and Nickerson, 1991). Losses associated with mastitis in dairy cows are estimated to be over $2 billion annually (Philpot and Nickerson, 1991). Mastitis in dairy cows causes decreased milk production, increased milk somatic cell count (**MSCC**), and alters milk components (Crossman et al., 1950; Philpot, 1967). On the contrary, mastitis in beef cows has received little attention. Milk yield accounts for more than 60% of the variation in calf preweaning weight gains (Rutledge et al., 1971; Boggs et al., 1980; Neville, 1962). Several studies conducted in beef cows have demonstrated that specific bacterial isolates, the total number of infected quarters, and cow age are capable of affecting calf weaning weight because of reduced milk production (Haggard et al., 1983; Watts et al., 1986; Newman et al., 1991). In addition, MSCC might vary according to the type of bacterial isolates identified. Several studies have demonstrated that the prevalence of mastitis in beef cows ranges from 7 to 54% of the cows and 2.6 to 29.2% of the quarters (Wilson et al., 1971; Haggard et al., 1983; Newman et al., 1991).

The objectives of this study were to determine 1) the effect of the number of infected quarters and pathogen group on calf weaning weight; 2) the effect of the number of infected quarters, regardless of the type of pathogen, on calf weaning weight and MSCC; 3) the effect of the types of bacterial isolates on MSCC and milk composition; and 4) the effect of parity on percentages of infected cows and infected quarters.

## Materials and Methods

*Experimental Animals.* One hundred and sixty-four Hereford and Hereford × Angus cows at the Oklahoma

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Agricultural Experimental Station in Stillwater were used. Cows were divided into three parity groups. The first group consisted of cows in their first parity (n = 21), the second group consisted of cows in their second through fourth parities (n = 76), and the third group consisted of cows in their fifth through ninth parities (n = 67).

Cows were maintained on native range and Bermuda grass pastures. When pastures were dormant, 20 to 40% CP supplements were fed to maintain cow body condition score between 4 and 5.5 (Wagner et al., 1988). When snow and ice covered standing forage, hay was fed. Cows calved from February through May on pasture. Cow weight and body condition score were obtained at least every 2 mo to assess nutritional management practices. Weaning weights of calves were adjusted to 205 d of age.

*Milk Sampling.* All animals were sampled at weaning in October following standard procedures (NMC, 1990). Calves were separated from their dams 2 to 3 h before milk collection to ensure the collection of adequate volumes of milk. Cows were directed into conventional squeeze chutes. Oxytocin (Vedco Inc., St. Joseph, MO) was administered i.m. at 10 U/cow (.5 mL) to facilitate milk let-down. Teats were cleaned individually as follows: loose dirt and manure were removed using paper towels, and teats were dipped into .1% iodine teat dip (Alfa Laval, Agri Inc., Kansas City, MO) and wiped dry with paper towels. Cotton soaked with 70% ethanol was used to clean the teat end and orifice. Cleaning with alcohol-soaked cotton was repeated until the cotton appeared to be completely clean. The first streams of milk were discarded and 3 mL was collected aseptically from each teat into snap-cap sterile plastic tubes (Fisher Chemical Co., Pittsburgh, PA) for bacteriological analysis. Also, 10 mL of milk was collected from each quarter to determine MSCC and milk composition; milk was collected into vials (Fisher Chemical Co.) containing broad-spectrum microtabs as a preservative (D&F Control Systems, San Ramon, CA). All milk samples were kept on ice. After milk sampling, teats were dipped with the .1% iodine teat dip.

Milk samples for bacteriological analysis were frozen, packed on dry ice, and transported to the Immunology and Disease Resistance Laboratory (IDRL), USDA-ARS, Beltsville, MD, for later diagnostic bacteriology. Milk samples for MSCC and milk composition were sent to the DHI Laboratory at Oklahoma State University in Stillwater for analyses.

*Bacteriology.* Esculin blood agar plates and mannitol plates were made in the IDRL following standard procedures (NMC, 1990). Blood was obtained from calves by jugular puncture. Also, plates containing P-agar supplemented with acriflavine (Sigma Chemical Co., St. Louis, MO) were made, following standard procedures (R. L. Boddie, Hill Farm Research Station, Homer, LA, personal communication). Frozen milk samples were allowed to thaw at room temperature and were vortexed before plating. Milk aliquots (20 μL) were plated on one-fourth of a 100 × 15-mm Petri dish containing esculin blood agar (5% red blood cells) and on 100 × 15-mm Petri dishes containing mannitol and P-agar supplemented with acriflavine. Plates were incubated at 37°C and examined for bacterial growth at 24 and 48 h.

For a quarter to be considered infected, three or more colonies of the same organism had to be isolated from the esculin blood agar plate. The milk sample from a quarter was considered contaminated when three or more different organisms were isolated.

Identification of the microorganisms was based on colony morphology, hemolytic and hydrolytic patterns, Gram stain (Bacto Gram Stain Set, Difco Laboratories, Detroit, MI), catalase production (hydrogen peroxide, Sigma Chemical Co.) and tube coagulase test (Coagulase Plasma EDTA, Difco Laboratories). Tube coagulase tests were incubated at 37°C and examined for clot formation at 4 and 24 h. *Staphylococcus aureus* was identified by selective growth on P-agar supplemented with acriflavine (Sigma Chemical Co.), fermentation of mannitol, and a positive coagulase reaction. Coagulase-negative staphylococci (**CNS**) were further identified using an identification system for staphylococci, Api Staph (API-bio Merieux Vitex, Inc., Hazelwood, MO). Bacteria were passed four times on esculin blood agar plates and a second coagulase test was performed before Api Staph wells were inoculated. Streptococcal isolates were identified using cAMP esculin plates (Wilson et al., 1971), made in the IDRL under standard procedures (NMC, 1990). *Corynebacterium bovis* and *Bacillus* spp. were identified by time of appearance on incubated plates, colony morphology, and Gram stain.

*Milk Somatic Cell Count and Composition and Calf Weights.* Milk somatic cell counts were determined electronically by fluoro-opto-electronic method (Bently Instruments Somacount 300, Bentley Instrumental, Inc., Chasca, MN) and using reference standards (DQCI services, Inc., Mounds View, MN) for calibration. Milk components (protein, butterfat, lactose, and solids-not-fat) were determined by near-infrared spectroscopy with a Multi-Spec (Multispect, Inc., Wheldrake, York, UK). Calf weights were recorded at birth and after milk sample collection at weaning in October using a livestock scale.

*Statistical Analysis.* Different models were used to analyze the following response variables: calf weaning weight, MSCC, and milk composition. In all cases, an original model was developed based on meaningfulness of variables, meaningfulness of interactions, and availability of data to support the model. Sources of variation with no influence in the models as well as high-order interactions were removed based on their probability and correct estimation of the degrees of freedom, which is an indication of empty cells, making it possible to achieve final models for each of the response variables. Procedures used were either PROC GLM (SAS, 1989) for the weaning weight analysis and PROC MIXED (SAS, 1992) for the remaining response variables. Cow

within parity group was the random variable for the PROC MIXED procedure.

For weaning weight, data were analyzed according to the number of infected quarters in association with pathogen group that consisted of either major or minor pathogens, and also by the number of infected quarters regardless of the type of isolated pathogen. In both cases, the same model was used adjusting for sex of calf. Major pathogens included only *S. aureus*, whereas minor pathogens included *Bacillus* spp., CNS, *C. bovis*, *Streptococcus* spp. not *Streptococcus agalactiae*, and undetermined isolates. In cases in which both minor and major pathogens were found in different quarters of the same cow, the most pathogenic isolate was considered regardless of the number of quarters infected with either one. Calf weaning weight was also analyzed according to cow parity group (one, two to four, and five to nine parities), type of pathogen, and number of infected quarters regardless of type of pathogen present.

Actual counts for MSCC were transformed to natural logarithm for analysis. Cow weight at weaning, calf birth weight, julian birth date, and cow body condition score were used as covariates to adjust the different models.

The effect of parity on the percentage of cows and quarters infected, and percentage of quarters infected with CNS, *S. aureus*, and other bacteria were analyzed by chi-square (Ostle, 1964). Effect of parity on the percentage of blind quarters was not analyzed because some expected values were too small and the chi-square statistic may not be a valid test.

Least squares means and specific contrasts of interest are reported for weaning weight, MSCC, and milk composition. Means are reported for percentage of infected cows, percentage of infected quarters, percentage quarters infected with CNS, percentage quarters infected with *S. aureus*, and percentage quarters infected with other bacteria.

## Results and Discussion

*Bacteriology.* In this study, pathogen group was divided as either major (*S. aureus*) or minor (*Bacillus* spp., CNS, *C. bovis*, *Streptococcus* spp. not *Strep. agalactiae*, and undetermined isolates). This criterion was used because only a few isolates (.3%) of *Streptococcus* spp. were found, and we preferred looking at the effect of *S. aureus* alone.

The percentage of infected quarters was 31.7% (Table 1). This percentage was similar to the 27.5% reported previously in purebred (one through five lactations) and crossbred (one through eight lactations) beef cows in late lactation (Newman et al., 1991) but higher than the 18.1% reported in purebred and crossbred cows (Watts et al., 1986) and the 4.6 and 2.7% reported for confinement and range pasture beef cow operation systems, respectively (Haggard et al., 1983).

Of the infected quarters, infections with CNS, *S. aureus*, and other bacterial isolates were 16.5 ± 1.5, 8.2 ± 1.1 and 7.0% ± 1.0, respectively (Table 1). *Staphylococcus hyicus*, *Staphylococcus chromogenes*, and *Staphylococcus epidermidis* accounted for 6.1, 10.3, and 0.1% of the CNS-infected quarters. In another study with beef cows in late lactation (Newman et al., 1991), 2.5% of the quarters were infected with *S. hyicus*, which is less than the percentage observed in the present study for both subspecies of *S. hyicus*. In dairy cows, infections by CNS averaged 11% of the quarters (Hogan et al., 1987). Although CNS causes a slight increase in MSCC, it is considered as a minor intramammary pathogen. For the other bacterial isolates, *C. bovis*, *Streptococcus* spp. not *Strep. agalactiae*, *Bacillus* spp. and undetermined isolates accounted for 5.9, .3, .3, and .5%, respectively. The pathogenicity of *C. bovis* is debatable and its presence in the bovine udder may not be suggestive of a serious mastitis problem (LeVan et al., 1985). In fact, presence of *C. bovis* might prevent infection by more virulent mastitis pathogens (Nickerson and Boddie, 1994). The 5.9% infection rate observed for *C. bovis* in this study was lower compared with 18.2% found in another study during late lactation (Newman et al., 1991).

Gram-negative bacteria were never isolated. This is quite different from the situation in dairy cows. Because of the confined housing of dairy cows, exposure to environmental pathogens is high. Eighty-one percent of coliform infections in commercial dairy herds came from clinical cases of mastitis (Smith et al., 1985). *Streptococcus agalactiae* has rarely been isolated from infected quarters of beef cows (Sobari et al., 1976; Kirkbride, 1977). In the current study, *Streptococcus agalactiae* was not isolated from any of the infected quarters. The absence of this bacteria is in accordance with previous studies in beef cows (Wilson et al., 1971; Watts et al., 1986; Newman et al., 1991). In a study on cows that were used for nursing calves (Hunter and Jeffrey, 1975), an unexpected 18% of the quarters were infected with *Strep. agalactiae*. Possibly because some of the cows might have been dairy cows before becoming nurse cows, infection with *Strep. agalactiae* may have spread into the beef cow population by cross-suckling. In the present study, infections by *Streptococcus* spp. nonagalactiae were low and averaged only .3% of the quarters.

The average percentage of infected cows found in this study was 66.1% (Table 1). This percentage was higher than the 54.4% found in purebred (one through five lactations) and crossbred (one through eight lactations) beef cows in late lactation (Newman et al., 1991), the 42.3% (Sobari et al., 1976), the 40% (LeVan et al., 1985), the 37% found in purebred Hereford and crossbred Hereford × Brahman and Hereford × Brown Swiss (Watts et al., 1986), and the 11.9% (Haggard et al., 1983) reported previously. Reasons for these differences are not obvious because similar isolation techniques were used. In the present study, the greater overall percentage of infected cows might be attributed to cross-suckling, which is known to occur in beef cows (Newman et al., 1991).

**Table 1**. Percentage of cows with infected mammary quarters and percentage of total infected quarters within each parity group

| Variable, % | Parity group 1[a] | 2 to 4[a] | 5 to 9[a] | $P <$[b] | Overall[c] |
|---|---|---|---|---|---|
| Infected cows | 61.9 | 66.8 | 66.7 | NS[d] | 66.1 |
| Infected QT | 25.0 | 27.2 | 39.1 | .01 | 31.7 |
| CNS[e] | 21.4 | 17.2 | 14.1 | NS | 16.5 |
| *S. aureus* | 1.2 | 4.4 | 15.0 | .01 | 8.2 |
| Other[f] | 2.3 | 5.6 | 10.0 | NS | 7.0 |
| Blind QT | 0 | .7 | 3.7 | NA[g] | 1.8 |

[a]n = 21, 76, and 67 cows for parity groups 1, 2 to 4, and 5 to 9, respectively.
[b]Chi-square analysis showed significance for infected quarters and *Staphylococcus aureus*.
[c]Represents overall results of the herd (n = 164 cows).
[d]NS = not significant.
[e]CNS = Coagulase-negative staphylococci.
[f]Other grouped the following species: *Bacillus* spp., *Corynebacterium bovis*, *Streptococcus* spp. not *Streptococcus agalactiae*, and undetermined isolates.
[g]NA = Not analyzed.

Because of the uneven distribution of cows by parity group, the data set was unbalanced and chi-square was used to evaluate infection in cows and quarters by parity. Parity did not influence ($P > .10$) the percentage of infected cows (Table 1). The percentage infected primiparous cows in this study was greater than the percentage of primiparous Simmental cows (32%) found in another study (Simpson et al., 1995). In a study of a confinement beef herd in which samples were taken in early lactation, the percentage of infected cows averaged 7.7, 12.9, and 17.1% for 2 to 3, 4 to 6, and >7-yr-old cows, respectively (Haggard et al., 1983). In the same study, for beef cows under a range pasture operation system, the percentage of infected cows was 13.5 and 7.9% for 2- and 3-yr-old cows, respectively. In the confinement beef herd operation, the percentage of infected cows increased as cow age increased. The increase in the incidence of mastitis found in beef cows with respect to parity is comparable to the increase found in dairy cows with respect to parity (Philpot and Nickerson, 1991).

The percentage of infected quarters increased ($P < .01$) with cow parity group from 25.0% ± 4.8 to 27.2% ± 2.6, and to 39.1% ± 3.0 for one, two to four, and five to nine parities, respectively (Table 1). In studies on purebred and crossbred primiparous and multiparous cows, an increase in the prevalence of infected quarters has also been found as cow age and stage of lactation increase (Sobari et al., 1976; Newman et al., 1991). Compared with the results in the current study, a lower percentage (18%) of infected quarters for primiparous beef cows and a greater percentage (48.3%) of infected quarters for primiparous dairy (Holstein and Jersey) cows have been reported (Simpson et al., 1995).

In addition, the percentage of infected quarters was analyzed according to the type of bacterial isolates found within each parity group (Table 1). Parity did not influence ($P > .10$) the percentage of quarters infected with CNS. Primiparous cows had a lesser percentage of quarters infected with *S. aureus* and other bacterial isolates. Compared with primiparous cows, four- and twelve-fold increases in the percentages of quarters infected with *S. aureus*, and two- and four-fold increases in the percentages of quarters infected with other bacteria were observed in cows with two to four and five to nine parities, respectively. Other studies have also isolated *S. aureus* from beef cows, with the incidence ranging from .5 to 10.2% of the infected cows (Sobari et al., 1976; Kirkbride, 1977). The overall percentage of quarters infected with CNS, *S. aureus*, and other bacterial isolates was 16.5, 8.2, and 7.0%, respectively. The percentage of quarters infected with *S. aureus* was higher than the 3.2% (Newman et al., 1991) or the 7.1% (Watts et al., 1986) found in other studies and less than the 9.8 and 10.7% found in confined and range pasture herds (Haggard et al., 1983). The range of prevalence of *S. aureus* infection found in beef cows falls in the lower ranges for that reported in dairy cows (Fox and Hancock, 1989).

In dairy cows, *S. aureus* is considered a contagious organism, easily spread among cows during milking. Common management practices, such as teat dipping and dry cow therapy, in dairy cows help reduce its prevalence (Eberhart et al., 1983; Philpot and Nickerson, 1991). For beef cows, differences in management could explain why its prevalence varies considerably from herd to herd (Newman et al., 1991). Because teat dipping and dry cow therapy are not practiced in beef cows, percentages of *S. aureus* infections would be expected to be greater in beef cows. The advantage for beef cows of not having infections by *S. aureus* spread from cow to cow during milking might be counteracted by the nursing calf. The calf may act as a vector in spreading infections from one quarter to another in the same cow and from one cow to another cow (Day et al., 1987).

*Blind Quarters.* The percentages of blind quarters appeared to increase with parity group (Table 1); however, this could not be tested because of the small inci-

dence of dry quarters. Primiparous cows had no blind quarters; in cows with two to four parities, .7% of the quarters were blind; and, in cows with five to nine parities, 3.7% of the quarters were blind. The overall percentage of blind quarters observed in this herd was 1.8%. In a study using primiparous Simmental cows, a total of 4% of the quarters were nonfunctional during some point of the study (Simpson et al., 1995). Blind quarters in beef cows may result from intramammary infections, physical injury, or other unknown factors.

*Milk Somatic Cell Count.* Average milk somatic cell count for all quarters of a cow increased as the number of infected quarters in each cow increased (Table 2). Milk somatic cell count was higher for one to two infected quarters ($P < .01$) and for three to four infected quarters ($P < .001$) when each was compared to zero infected quarters. The values for MSCC obtained for infected quarters were similar to those reported in another study for uninfected quarters (Watts et al., 1986) but lower than those reported by Newman et al. (1991). Calf weaning weight and MSCC analysis according to the number of infected quarters regardless of type of pathogen are presented (Table 2). Calf weaning weight did not change ($P > .10$) as the number of infected quarters increased from zero to four. One study reported that 210-d weaning weight of calves was influenced by the number of infected quarters of the cow (Watts et al., 1986). Calves nursing cows with one, two, three or four infected quarters had lighter weaning weights than those nursing uninfected cows. Mean calf weaning weight observed in the current study is similar to the mean adjusted 205-d weaning weight reported for Angus cows in a confinement operation system (Haggard et al., 1983).

Milk somatic cell count was not influenced ($P > .10$) as parity group increased from one to nine (Table 3). In agreement with this study, Wilson et al. (1971) showed that in crossbred Angus × Holstein cows of one to five parities, the number of parities had no effect on MSCC. Values for MSCC for the different parity groups found in the current study were lower than reported in the previous study. The average MSCC for beef cows in this study were similar to those reported for dairy cows (Paape et al., 1973, 1975).

*Calf Weaning Weight.* Neither the number of infected quarters (Table 2) nor pathogen group (data not shown) affected calf weaning weight ($P > .10$). This is in agreement with a previous study in which no difference was found for 205-d weight between calves nursing quarters infected with *S. aureus* or *Streptococcus dysgalactiae* and calves nursing cows infected with other isolates (Simpson et al., 1995). In a study with Polled Hereford and Charolais cows, infection with *S. aureus* in the dam had no effect on calf weaning weight (Simpson et al., 1994).

Other investigators have found opposite results. Adjusted weaning weights of calves nursing cows infected with *S. aureus* were less than calves nursing uninfected cows (Haggard et al., 1983; Watts et al., 1986; Newman et al., 1991). In a study in which the level of infection was determined in early lactation, significant differences in calf weight gain between calves nursing from *S. aureus*-infected and -uninfected cows was observed during the preweaning period (0 to 205 d) (Newman et al., 1991). In the same study, calves nursing cows infected with any kind of pathogen during d 60 to 100 of the preweaning period and calves nursing cows infected with *S. aureus* or *C. bovis* during the 60- to 205-d preweaning period had lower weight gains than calves nursing uninfected cows.

In dairy cows, there is a negative correlation between milk production and intramammary infections (Philpot and Nickerson, 1991). The same correlation probably also occurs in beef cows. Therefore, as the number of infected quarters in a cow increases, milk production likely decreases, resulting in lower calf weaning weight. We failed to find such differences because of the confounding effect of nutritional and environmental factors that influenced calf weaning weight. Any difference in calf weaning weight due to lower production would probably be detected in calves from cows that had three or four infected quarters. In this study, when the number of infected quarters increased from one to four, only a nonsignificant numerical reduction for calf weaning weight was observed. Other studies (Gleddie and Berg, 1968; Rutledge et al., 1971; Boggs et al., 1980) demonstrated that milk production of beef cows accounted for 60 to 71.3% of the variation of adjusted calf weaning weight and calf preweaning weight gains. Failure to find differences in weaning weight in this study could be due to lower milk production of younger cows, and more healthy quarters.

**Table 2**. Calf weaning weight and milk somatic cell count (MSCC) according to the number of infected quarters

| | Number of infected quarters | | | | | | Contrast ($P <$)[a] | | |
|---|---|---|---|---|---|---|---|---|---|
| Variable | 0 | 1 | 2 | 3 | 4 | SE[b] | 0 vs 1–2 | 0 vs 3–4 | 1–2 vs 3–4 |
| Weaning weight, kg[c] | 194 | 201 | 198 | 196 | 189 | 7.7 | NS[d] | NS | NS |
| MSCC, cells × $10^3$/mL[e] | 35.2 | 61.1 | 63.6 | 121.8 | 191.0 | 1.3 | .01 | .001 | .001 |

[a]Overall ANOVA was significant for MSCC.
[b]SE = polled standard error based on 164 calves.
[c]Calves were weaned in mid-October 1993 at an average age of 235 ± 1.6 d. Range of julian birth date was 5 to 111 d.
[d]NS = not significant ($P > .10$).
[e]Analysis was performed on data transformed to natural log.

**Table 3**. Calf weaning weight, milk somatic cell count (MSCC), and milk components according to parity group

| Variable | Parity group | | | | Contrast ($P <$)[a] | |
|---|---|---|---|---|---|---|
| | 1 | 2 to 4 | 5 to 9 | SE[b] | 1 vs 2 to 9 | 2 to 4 vs 5 to 9 |
| Weaning weight, kg[b] | 169 | 208 | 211 | 6.8 | .001 | NS[c] |
| MSCC, cells × $10^3$/mL | 69 | 94 | 117 | 1.2 | NS[d] | NS |
| Milk components, % | | | | | | |
| Protein | 3.73 | 3.84 | 3.81 | .08 | NS | NS |
| Butterfat | 3.43 | 4.31 | 3.82 | .21 | .10 | .05 |
| Lactose | 4.78 | 4.66 | 4.61 | .04 | .10 | NS |
| Solids-not-fat | 9.37 | 9.30 | 9.17 | .07 | NS | NS |

[a]ANOVA showed significance for weaning weight, butterfat, and lactose.
[b]SE = pooled standard error.
[c]NS = not significant ($P > .10$).
[d]Calves were weaned in mid-October 1993 at an average age of 235 ± 1.6 d. Range of Julian birth date was 5 to 111 d.

*Milk Composition.* Analysis of percentages of milk composition according to parity group showed a different pattern for each component (Table 3). Percentages of protein and solids-not-fat were not different ($P > .10$) among cow parity groups. However, butterfat tended to be less ($P < .10$) in cows with one parity than in cows with two to nine parities. Within multiparous cows, cows with two to four parities produced milk with a greater ($P < .05$) percentage of butterfat than cows with five to nine parities. Lactose tended to be greater ($P < .10$) in primiparous cows than in multiparous cows. Lactose percentage for cows of two to four parities compared with cows of five to nine parities were not different ($P > .10$). The major constituents reported in this study for beef cows were similar to those reported for dairy cows (Schalm et al., 1971).

The type of bacterial isolates found in milk affected all of the milk components (Table 4). Percentages of protein ($P < .05$), lactose ($P < .001$), and solids-not-fat ($P < .001$) were greater and, butterfat tended to be greater ($P < .10$) in milk from uninfected quarters than in milk from cows with infected quarters; in particular, the percentages were less in milk from *S. aureus*-infected quarters. Within infected quarters, butterfat percentage was not different ($P > .10$), protein percentage tended to be less ($P < .10$), and lactose percentage and of solids-not-fat were lower ($P < .001$) in milk from quarters infected by *S. aureus* than in quarters infected by CNS and other bacterial isolates. Similarly, in another study, *S. aureus*-infected quarters were also associated with lower values for milk protein percentage than uninfected quarters (Watts et al., 1986). Comparing the effects of type of bacterial isolate with MSCC and milk components, one can observe that the lowest MSCC in infected quarters was associated with the highest percentage of milk components, whereas the opposite was true for quarters infected with *S. aureus*. The opposite was found in a previous study in which cows with high MSCC had greater percentage of protein and butterfat in late lactation than cows with low MSCC (Simpson et al., 1995).

On the basis of the results of this study, we conclude that intramammary infections in beef cows did not affect calf weaning weight. Coagulase-negative staphylo-

**Table 4**. Milk somatic cell count (MSCC) and milk components according to the type of bacterial isolate

| Variable | Type of bacterial isolate | | | | | Contrast ($P <$)[a] | | |
|---|---|---|---|---|---|---|---|---|
| | Uninfected | CNS[b] | *S. aureus* | Other[c] | SE[d] | Uninfected vs infected | Uninfected vs *S. aureus* | *S. aureus* vs CNS + others |
| MSCC, cells × $10^3$/mL[e] | 36 | 205 | 248 | 37 | 1.2 | NS[f] | .10 | NS |
| Milk components, % | | | | | | | | |
| Protein | 3.82 | 3.79 | 3.76 | 3.81 | .05 | .05 | .05 | .10 |
| Butterfat | 3.94 | 3.81 | 3.72 | 3.95 | .14 | .10 | .05 | NS |
| Lactose | 4.74 | 4.66 | 4.58 | 4.76 | .03 | .001 | .001 | .001 |
| Solids-not-fat | 9.36 | 9.24 | 9.14 | 9.38 | .05 | .001 | .001 | .001 |

[a]ANOVA showed significance for MSCC and milk components.
[b]CNS = Coagulase negative staphylococci.
[c]Other constituted of *Bacillus* spp., *Corynebacterium bovis*, *Streptococcus* spp. not *Streptococcus agalactiae*, and undetermined isolates.
[d]SE = pooled standard error.
[e]Analysis was performed on data transformed to natural log.
[f]NS = not significant ($P > .10$).

cocci were the most common organisms isolated from early-parity cows, whereas *S. aureus* was the most common organism for later-parity cows. Intramammary infection increased MSCC and decreased the percentages of protein, lactose, solids-not-fat, and butterfat.

## Implications

Results indicate that 66% of beef cows on pasture have subclinical mastitis, and 15% of all mammary quarters for cows with five to nine parities are infected with *Staphylococcus aureus*. For beef cows with fewer parities, only 1 to 4% of the quarters are infected. This organism is a serious mastitis pathogen that destroys mammary secretory tissue and causes decreased milk production. It is spread from cow to cow through the transfer of infected milk from one mammary quarter to another by suckling. Weaning weight of calves from cows with subclinical mastitis in four mammary quarters was 5 kg less than herd mates free from intramammary infection. A mastitis control program for beef cows may reduce incidence of mastitis and the spread of *S. aureus* and increase calf weaning weight.

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